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# A STUDY OF GLASS SANDS FROM DARA PEZU AND MIANWALI AREAS

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A laboratory investigation was carried out on fourteen samples of sands from Dara Pezu and Mianwali to study their suitability in glass industry. The investigation involves the removal of coarse and fine grains, washing treatment and finally magnet application. The percentage of $Fe_2O_3$ in raw as well as in final products was determined. The sand sample No. V from Dara Pezu containing iron 0.04% was found to be the best of the whole lot. Sample Nos. II and III from Mianwali containing iron 0.05% come next in the order. All the above three sands may, therefore, be used for making colourless and laboratory glasswares.

## INTRODUCTION

The Mianwali and D.I. Khan areas are lacking in most of the pure non-metallic minerals necessary to attract glass industries. Among these impure non-metallic minerals silica sands used in glass industry stand prominent. The purpose of this study was to make the available sands suitable by simple beneficiation methods for use in making good quality glass. Thus to determine the effectiveness of minerals dressing procedures in removing impurities from the sand, that is, to reduce the $Fe_2O_3$ content below the maximum specified limit for glass sand and to reduce the $Al_2O_3$ content by removing a portion of clay and feldspar, the simple beneficiation methods were employed.

To accomplish these objectives, samples were taken from 14 localities, eight from Dara Pezu and six from Mianwali areas. Selected samples were subjected to grain size distribution, water treatment and magnetic benefication.

In general, specifications for all grades of glass sand are quite similar except for iron oxide content which is quite rigid but varying for different applications. According to British specifications[1], sand used for making clear container glass should preferably contain not more than 0.05% $Fe_2O_3$. Silica content should be high, usually in the range of 95-98% other oxides such as $Al_2O_3$, CaO, MgO, $Na_2O$ and $K_2O$ do not have rigid limits since they are normal constituents of the glass batch; however, the content of these oxides should be constant. A physical size range of 25 to 100 mesh is usually specified[2].

## EXPERIMENTAL

1. *Removal of Coarse Grains.* The object of this grading is to remove coarse grains of sand as they produce "Stones" in the final glass. Also, the coarse grains contain a higher percentage of $Fe_2O_3$ which is not desirable for high quality glass. Two kg of each sand sample was sieved with B.S test sieve No 25 (599 microns), and +25 fraction was weighed and percentage of coarse fraction calculated. The results are shown in Table 1.

2. *Washing Treatment.* The purpose of washing is to remove clayey fraction which is rich in iron content. The whole of –25 fraction (from step 1) was washed thoroughly with some quantity of water in a big stainless steel beaker. Water washing was accomplished with gentle agitation. Each washing was decanted off carefully so that no sand grain was washed away. When the washings were found clear, the washed sand was dried in the sun.

3. *Removal of Fine Grains.* After washing, the dry sand was again graded so as to remove finer particles. The sand was passed through a B.S. test sieve No: 120 (125 microns). Both the fraction i.e.(–25+125) and (–120) were weighed separately and percentages calculated in each case. (Table 1).

The removal of –120 fraction is essential as the finer particles cause seeding in the glass. Moreover, the iron content in the –120 fraction is also very high[3].

4. *Magnet Treatment.* Each (–25+125) fraction was subjected to magnetic treatment. Paramagnetic and ferromagnetic materials were thus removed so as to further reduce iron content in the same.

## RESULTS AND DISCUSSIONS

According to the standard specifications, the grains of the sand should be approximately of uniform size. In order to help the smooth melting of the sands they should have

Table 1. Grading

| Sand No. | +25 Fraction % | (−25 Washed +120 fraction % | -120 fraction % |
|---|---|---|---|
| D.P.I. | 3.1 | 60.5 | 36.4 |
| D.P.II | 4.0 | 37.5 | 58.5 |
| D.P.III | 4.0 | 63.5 | 32.5 |
| D.P.IV | 0.0 | 13.0 | – |
| D.P.V | 1.3 | 53.5 | 45.2 |
| D.P.VI | 22.5 | 65.7 | 11.8 |
| D.P. VII | 26.7 | 48.0 | 25.3 |
| D.P.VIII | 4.2 | 59.0 | 36.8 |
| M-I | 1.1 | 76.0 | 22.9 |
| M-II | 26.3 | 61.2 | 12.5 |
| M-III | 20.3 | 63.5 | 16.2 |
| M-IV | 9.8 | 60.5 | 29.7 |
| M-V | 10.5 | 29.3 | 60.2 |
| M-VI | 0.3 | 71.3 | 28.4 |

the grains sizes between 25-mesh and 120-mesh, as coarser particles are difficult to melt and finer particles tend to produce seeds in the glass and create dust control problems. All the grains size data is presented in Table 1. From the Table it appears that sand No. D.P. IV has the lowest percentage of useful fraction (13.0%), whereas No. M-I has the largest percentage of useful fraction (76.0%) others are in between. Majority of the sands have useful fraction between 50-75%. This is thus commercial to carry out the grading and the washing at the site of the deposits otherwise, it will be costly to incur the freight charges for the unwanted rejected material.

It is known that the chemical analysis of sand gives a clear picture of its use in the glass making which was carried out according to the British Standards [4]. Iron, either in the ferrous or ferric state, because of its colouring effect upon glass, is the most deterimental impurity found in glass sands. The ferrous iron imparts a green tint to glass, while the ferric iron produces a yellow tint. Since most of the glasses are made under slightly reducing conditions, only the green colour is usually developed. This study was, therefore, restricted to the determination of iron in raw and beneficiated sands. Having this in view when we study iron contents of the raw and treated sands presented in Table 2, it appears that in raw state all the sands contain iron over 0.1% and thus are not at all suitable for glass making in raw state. Some of them have, however, proved very good after grinding, washing, and magnet treatment. Thus sample No. D.P.V. after treatment gives only 0.04% $Fe_2O_3$. Similarly sample Nos. MII and MIII give 0.05% iron oxide. Complete chemical analysis of the above three samples are given in Table 3. From the Table it appears that they contain pure silica around 98%, $Al_2O_3$ around 1.0% $Fe_2O_3$, 0.05% or less and alkaline earths less than 1.0%. Samples Nos. MIV,

Table 2. Chemical analysis

| Sand No. | Raw sand ($Fe_2O_3$) % | Washed, graded and magnet treated sand ($Fe_2O_3$) % |
|---|---|---|
| D.P.I. | 0.105 | 0.075 |
| D.P.II | 0.40 | 0.25 |
| D.P.III | 0.17 | 0.10 |
| D.P. IV | 0.05 | – |
| D.P. V | 0.075 | 0.04 |
| D.P. VI | 0.175 | 0.14 |
| D.P. VII | 0.35 | 0.08 |
| D.P. VIII | 0.015 | 0.075 |
| M-I | 0.21 | 0.125 |
| M-II | 0.105 | 0.05 |
| M-III | 0.165 | 0.05 |
| M-IV | 0.18 | 0.075 |
| M-V | 1.30 | 0.12 |
| M-VI | 0.30 | 0.20 |

Table 3. Analysis of final product

| | D.P.V. graded-washed-magneted % | M-II % | M-III % |
|---|---|---|---|
| I/L | 0.18 | 0.35 | 0.17 |
| $SiO_2$ | 98.7 | 97.64 | 98.30 |
| $Al_2O_3$ | 0.91 | 1.15 | 1.05 |
| $Fe_2O_3$ | 0.04 | 0.05 | 0.05 |
| CaO | 0.25 | 0.80 | 0.55 |
| MgO | 0.08 | 0.06 | 0.08 |
| | 100.16 | 100.05 | 100.20 |

D.P.I., D.P. VIII and D.P. VII come next in the order having 0.075% and 0.08% $Fe_2O_3$ respectively. It is known [5] that decolourization may be effected, provided the iron content of a glass does not exceed 0.1% of the batch. Thus sand No. D.P. III may also be used provided the other constituent. of the glass batch, having $Fe_2O_3$ more than 0.1% Finally it may be suggested that sands Nos. D.P.V., MII and MIII after proper beneficiation may be utilized for making white colourless glasses. Sands Nos. MIV, D.P.I. D.P. VIII, D.P. VII and D.P. III may also be tried alongwith decolorisers for making medium quality glasswares.

## CONCLUSIONS

1. Sand No. D.P.V. is the best containing 0.04% $Fe_2O_3$. This could be used for making good quality colourless borosilicate and other glasses.
2. Sand Nos. MII and MIII come next containing 0.05% $Fe_2O_3$. These could also be used for making colourless glasses.
3. Sand Nos. MIV, D.P.I., D.P. VIII, D.P. VII and D.P. III may be placed in the order cited and could be used for medium quality glass. For this purpose they have to be treated with various decolourizing agents in the melting tank.
4. All the sands should be beneficiated at the mine site in order to remove the unwanted materials and thus to save the transport cost. A washing plant at the site, is therefore, a must.

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